We Claim

1. A method for determining and tracking the changing, true position and orientation of a magnetic field sensor within a three-dimensional magnetic field space from measuring position and measuring orientation values measured by the magnetic field sensor, comprising:

structuring the magnetic field space into a three-dimensional grid with equidistant grid points;

successively measuring values with the magnetic field sensor with constant orientation while the magnetic filed sensor is positioned at each of the different grid points;

storing the values in a calibration table as calibration positions and calibration orientations associated with real positions of the grid points in a real space coordinate system;

determining four calibration positions from the calibration table that span a tetrahedron enclosing the measuring position in a calibration space coordinate system; and

for continuously measured, actual measuring values from the magnetic field sensor, performing a linear interpolating transformation of the measuring position to the real space coordinate system based on the four calibration positions; and outputting the transformed measuring position as a true position of the magnetic field sensor.

2. The method according to claim 1, further comprising determining a transformation matrix (A) based on the four calibration positions, such that the four calibration positions are

transformed to the real space coordinate system and that the measuring position is transformed with the aid of the transformation matrix (A).

3. The method according to claim 2, further comprising:

displacing a first position of the four calibration positions to a point of origin of the calibration space coordinate system prior to the transformation;

displacing the other three calibration positions by the position coordinates of the first calibration position;

displacing a first grid-point position associated with the first calibration position to a point of origin of the real space coordinate system;

displacing the other three grid-point positions by position coordinates of the first grid-point position, wherein a transformation with the displaced calibration positions ($\vec{p}_i^{M,V}$) and the displaced grid-point positions ($\vec{p}_i^{V}$) is realized as:

$$\vec{p}_i^{V} = A\,\vec{p}_i^{M,V} \qquad \text{with } i = 1,2,3 \qquad (1)$$

4. The method according to claim 3, further comprising:

applying the transformation matrix (A) to the measuring position ($\vec{p}^{M,V}$), displaced by the position coordinates of the first calibration position, as follows:

$$\vec{p}^{V} = A\,\vec{p}^{M,V} \qquad (2)$$

and

following this transformation, reversing the displacement in the real space coordinate system.

5. The method according to claim 1, further comprising:

determining on which side of surfaces of the tetrahedron the measuring position is located; and

identifying the measuring position as enclosed if the measuring position on all surfaces of the tetrahedron is located on the same side of the tetrahedron surface as a fourth tetrahedron point that is not included in the tetrahedron surface.(?)

6. The method according to claim 5, further comprising:

defining two vectors between a first corner point (P_1) of the tetrahedron surface and the two other corner points (P_2, P_3);

computing a cross product of the two vectors;

defining one additional vector between the first corner point (P_1) of the tetrahedron surface and the fourth tetrahedron point (P_4) that is not included in the tetrahedron surface and the measuring position (P_M);

computing scalar products of the cross product vector resulting from the cross product for each of the additional vectors; and

recognizing the measuring position as being located on the correct side of the tetrahedron surface if the scalar products have the same algebraic signs.

7. The method according to claim 5, wherein determining the four calibration positions comprises:

determining a space element spanned by eight calibration positions that are associated with eight grid-point positions describing a cube in the real space coordinate system; and

performing a tetrahedron test each of six tetrahedrons in the space element.

8. The method according to claim 7, wherein the cube encloses a true position that is predicted with the aid of at least one preceding measuring cycle.

9. The method according to claim 5, wherein determining the four calibration positions comprises:

determining a space element spanned by calibration positions for which the associated grid-point positions in the real space coordinate system describe a plurality of adjoining cubes that are grouped around a central grid-point position; and

performing a tetrahedron test for each of the tetrahedrons in the space element.

10. The method according to claim 7, further comprising stopping the tetrahedron test when a tetrahedron enclosing the measuring position is located.

11. The method according to claim 9, further comprising selecting the grid-point position closest to a true position predicted with the aid of at least one preceding measuring cycle as the central grip-point position.

12. The method according to claim 9, further comprising selecting the grid-point position for which the associated calibration position is closest to a global calibration position determined during a global search performed in the calibration space coordinate system as the central grid-point position.

13. The method according to claim 12, further comprising:

determining a distance to the measuring position during the global search for all calibration positions stored in the calibration table; and

outputting the calibration position with the shortest distance as the global calibration position.

14. The method according to claim 12, further comprising:

dividing the calibration table is into several table regions;

defining a cumulative position for each table region;

determining the distance between the measuring position and the cumulative position during the global search ; and

outputting the cumulative position with the shortest distance as the global calibration position.

15. The method according to claim 14, wherein the table regions are determined such that each cumulative position is determined with the aid of approximately the same number of calibration positions.

16. The method according to claim 1, further comprising:

determining a correction orientation with the aid of the true position of the magnetic field sensor; and

applying the correction orientation to the measuring orientation for determining the true orientation of the magnetic field sensor.

17. The method according to claim 16, further comprising performing a trilinear interpolation to determine the correction orientation with the aid of the calibration orientations, for which the associated grid-point positions span a cube enclosing the true position in the real space coordinate system.

18. A method of determining a position of a magnetic filed sensor, comprising:

determining four calibration points from a calibration table that span a tetrahedron in a calibration space coordinate system that encloses a measuring position measured by the magnetic field sensor;

performing a linear interpolating transformation of the measuring position to a real magnetic field space based on the four calibration points; and

outputting the transformed measuring position a true magnetic sensor position.

19. The method of claim 18, further comprising:

displacing a first of the four calibration points to an origin of the calibration space coordinate system; and

displacing the other of the four calibration points by position coordinates of the first of the four calibration points.

20. The method of claim 19, further comprising:

displacing a first grid point associated with the first of the four calibration points to an origin of a real space coordinate system; and

displacing grid points associated with the other of the four calibration points by position coordinates of the first grid point.

21. The method of claim 18, further comprising:

selecting eight calibration points from the calibration table that are associated with grid points in the real space coordinate system that span a cube enclosing the true magnetic sensor position; and

performing a trilinear interpolation with the eight calibration points to determine a correct orientation of the magnetic sensor.